Thermo
SCIENTIFIC

Air-Jacketed Large Capacity Automatic CO_2 Incubators

Model No.
393, 393-1
393-2, 393-3

057-014-00 • 2/5/07

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Safety Information

Alert Signals

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Warnings alert you to a possibility of personal injury.

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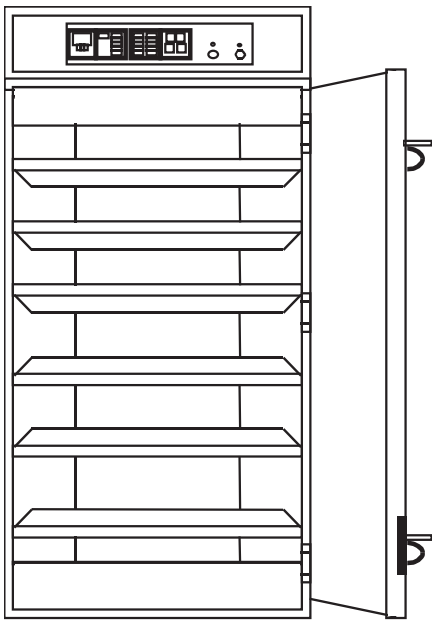
Cautions alert you to a possibility of damage to the equipment.

Note
Notes alert you to pertinent facts and conditions.

Hot Surface
Hot surfaces alert you to a possibility of personal injury if you come in contact with a surface during use or for a period of time after use.



Model 393

The Thermo Scientific Air-Jacketed Large-Capacity, Automatic CO2 Incubators provide precise and reliable control of carbon dioxide, temperature and humidity through a microprocessor-based command control console. All required operating commands are immediately accessible in a functional format on the front of the unit and permit rapid start-up, close monitoring and efficient control of the incubation protocols.

Features include:

- Thermal conductivity (TC) sensor measures CO2 concentration
- Resistance Temperature Detector (RTD) sensor monitors temperature
- Exclusive SMARTGAS (algorithm) system for accurate CO2 control
- Audible and visual alarms indicate factory set limits are exceeded
- Easy-to-read LED display of temperature and CO2 concentration
- 6 shelves standard with incubator

Available options:

- Left hand door, **L**
- 12” x 48” (30 x 122 cm) glass window, **GW**
- Recorder, models 393-2 and 393-3

Specifications

Electrical Requirements
393/393-2: 120 Volts, 50/60 Hz, 1400 Watts, 11.7 Amps
393-1/393-3: 230 Volts, 50/60 Hz, 1400 Watts, 5.8 Amps

Temperature Range
Ambient +5°C to 60°C

Temperature Control
±0.1°C

Uniformity in Chamber
±0.25°C

Carbon Dioxide Tension
Range: 0% to 20%
Control: ±0.1%

Volume
34 cu. ft. (963 liters)

Humidity
Range: 20% above ambient to 98% relative humidity at 37°C
Accuracy: ±3%

Dimensions
Exterior: 42”W x 91”D x 35”H (107cm x 231cm x 89cm)
Chamber: 36”W x 65”D x 25”H (91cm x 165cm x 64cm)

Shelf Capacity
36 shelves

Net Weight
1020 lbs. (463 kg)

Unit's Environmental Operating Conditions

Pollution Degree:	2
Installation Category:	II
Altitude:	2000 meters MSL (Mean Sea Level)
Humidity:	80% maximum, non-condensing
Electrical Supply:	120VAC or 240VAC
Voltage Tolerance:	±10% of normal rated line
Temperature:	15°C to 40°C

Unpacking and Installation

Shipping Carton

The shipping carton should be inspected upon delivery. When received, carefully examine for any shipping damage before unpacking. If damage is discovered, the delivering carrier should both specify and sign for the damage on your copy of the delivery receipt.

Open the carton carefully making certain that all parts are accounted for before packaging materials are discarded. After unpacking, if damage is found promptly report it to the carrier and request a damage inspection promptly.

IMPORTANT: Failure to request an inspection of damage within a few days after receipt of shipment absolves the carrier from any liability for damage. You must call for a damage inspection promptly.

Leveling

Using a bubble-type level placed on a shelf can level the unit. Make the necessary adjustments by placing shims under the corner pads.

Adjustable Screw Guards for Protecting Back of Unit

Exercise care in placing the back of the unit against a wall to avoid damage to CO2 tubing and related attachments. To protect against this, 2 adjustable screw guards on the back are used to establish a buffer zone for the CO2 tubing. If unit is shipped upright, guards are in place; if shipped flat, guards are furnished loose and must be inserted.

Electrical Connection

Before making electrical connection, be certain that the outlet provides the power requirements matching those listed on the unit's nameplate.

Shelf Installation

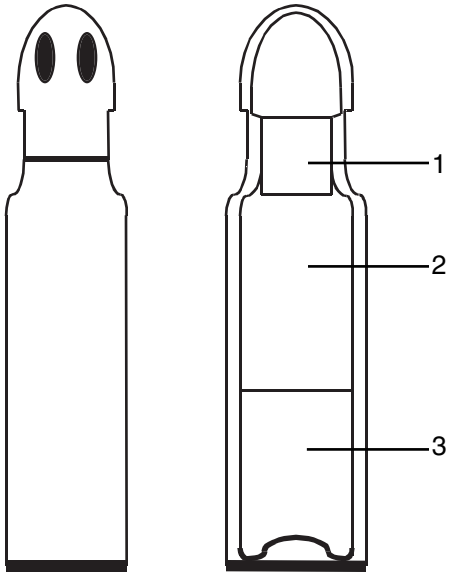
Attach shelf support clips to brackets inside the chamber. Slide shelves into place. A symmetrical arrangement of shelves helps to circulate CO2 and heat uniformly in the chamber.

CO2 Connection

Be sure to use lab-grade, dry carbon dioxide cylinders. Do not use a CO2 cylinder marked "Siphon" or "Eductor Tube." These are intended expressly for making dry ice and are not suitable for use with this incubator.

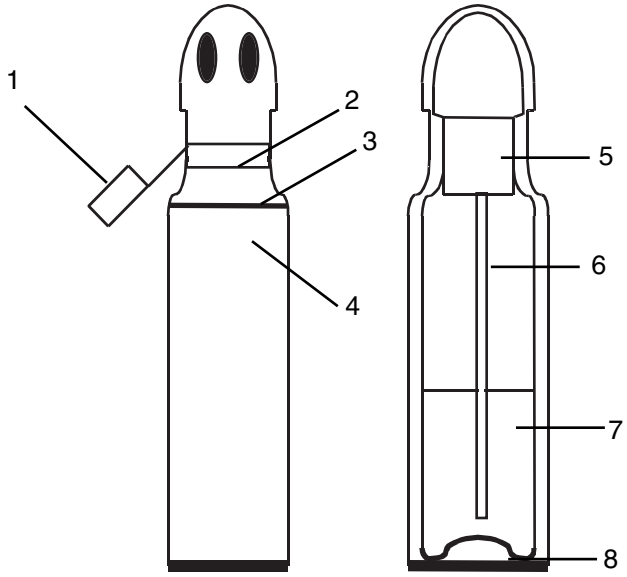
Standard and Siphon Type CO2 Gas Cylinders

Standard Type (Correct)



1. Compressed Gas Association #320 connector.
2. Gas head space.
3. Liquid CO2 filled to 68% equal weight of water that cylinder would hold at 60ºF.

Siphon Type (Incorrect)



1. Warning tag indicating that cylinder is siphoning type.

2* Aluminum ring.

3* Gold band.

4* Stamp or marking on cylinder: "Siphon" or "Eductor Tube".

5* Valve should be of special type for service.

6* Withdrawal tube draws up the liquid CO2.

7* Gas head-space.

8* Liquid CO2 filled to 68% equal weight of water that cylinder will hold at 60ºF.

*Note: Some gas suppliers will have no markings to indicate an “Educator Tube” or “Siphon” type cylinder. Be sure to order DRY, LAB-GRADE CO2.

Be sure to obtain a dual-stage regulator from the gas supplier for the CO2 tank that is to be installed according to local codes. Connect 1/4" ID (6.35 mm) flexible tubing to the regulator. Connect the other end of the tubing to the unit's CO2 inlet (located on the back top panel). Insert tubing over hose barb and fasten with an appropriate clamp to assure a proper connection. Adjust the regulator for 15 psi when CO2 is to be injected into chamber. For optimum results, do not exceed or reduce this pressure.

Humidification

Units have an integral humidifier that requires the attachment of tubing to a water source and condensation to drain.

The humidifier inlet, located on the incubator's back panel, has a compression fitting. Run a length of 1/4-inch (1.9 cm) polyethylene tubing from the inlet to the water supply. The humidifier overflow outlet is next to the inlet. Connect 1/4-inch (1.9 cm) polyethylene tubing to the compression fitting. Run tubing from this connection to a drain.

As a preventive measure against mineral deposit build-up, use only distilled water in the humidifier. Mineral deposits can affect CO2 control. The regulator protects the cartridge against excessive pressure. Pressure should be maintained between 10 and 15 psi.

Effect of Humidification on CO2 Measurement

Because the CO2 sensor technology used in the unit is sensitive to moisture, CO2 measurement will be influenced by RH (relative humidity) levels in the chamber. Changing RH levels can adversely affect CO2 measurement and produce a momentary, incorrect reading. Relatively small humidity levels tend to produce rapid fluctuations in CO2 measurement with greater possibility for error.

If the unit is calibrated for CO2 at 96% RH (maximum), a door opening may momentarily destabilize the RH level in the chamber and produce an incorrect CO2 reading. However, on door closing and subsequent recovery of the

RH to maximum level, the CO2 sensor will respond to a stable RH and again produce a correct measurement and display.

Note
Distilled water shall be provided by others at a minimum rate of 18 gallons-per-day and a minimum pressure of 40 psig with an electrical resistivity between **500 K ohms and 1 meg ohms.**

Note
The manufacturer expressly disclaims liability for damage to humidifier(s) and for loss sustained by the user as a result of humidifier failure, if such damage is the result of improper treatment of water used for humidification.

If further information is required, please contact Customer Service at 1-800-553-0039.

Be Advised About the Kind of Water to Use

Distilled or deionized water MUST BE USED for humidifier(s). ELECTRICAL RESISTIVITY OF THE DISTILLED WATER MUST BE BETWEEN 500 K OHMS AND I MEG OHMS as measured between opposite faces of a centimeter cube of an aqueous solution as per ASTMD 1125-82. Distilled water, if available, will give the best results and the longest life expectancy for the equipment. All DI and/or city water final connects shall be by others. If distilled water is unavailable and the user is unable to obtain suitable demineralizing equipment, the factory can provide demineralizer cartridges (Research 1, ITW Co. or the equivalent) for water treatment, which should be used for this humidification purposes. Due to the great variations in water hardness and chemical makeup from one geographical area to another, demineralizer cartridges may not, in all cases, be adequate to prevent damage to the internal wetted parts of the humidifier(s).

Purchasers are responsible for determining, through water analysis and recommendations by a qualified water treatment company, if further treatment is required, either before, after, or in place of using a demineralizer cartridge. If further water treatment is necessary or advisable, the user is obligated to supply and install all equipment that might be required for this purpose.

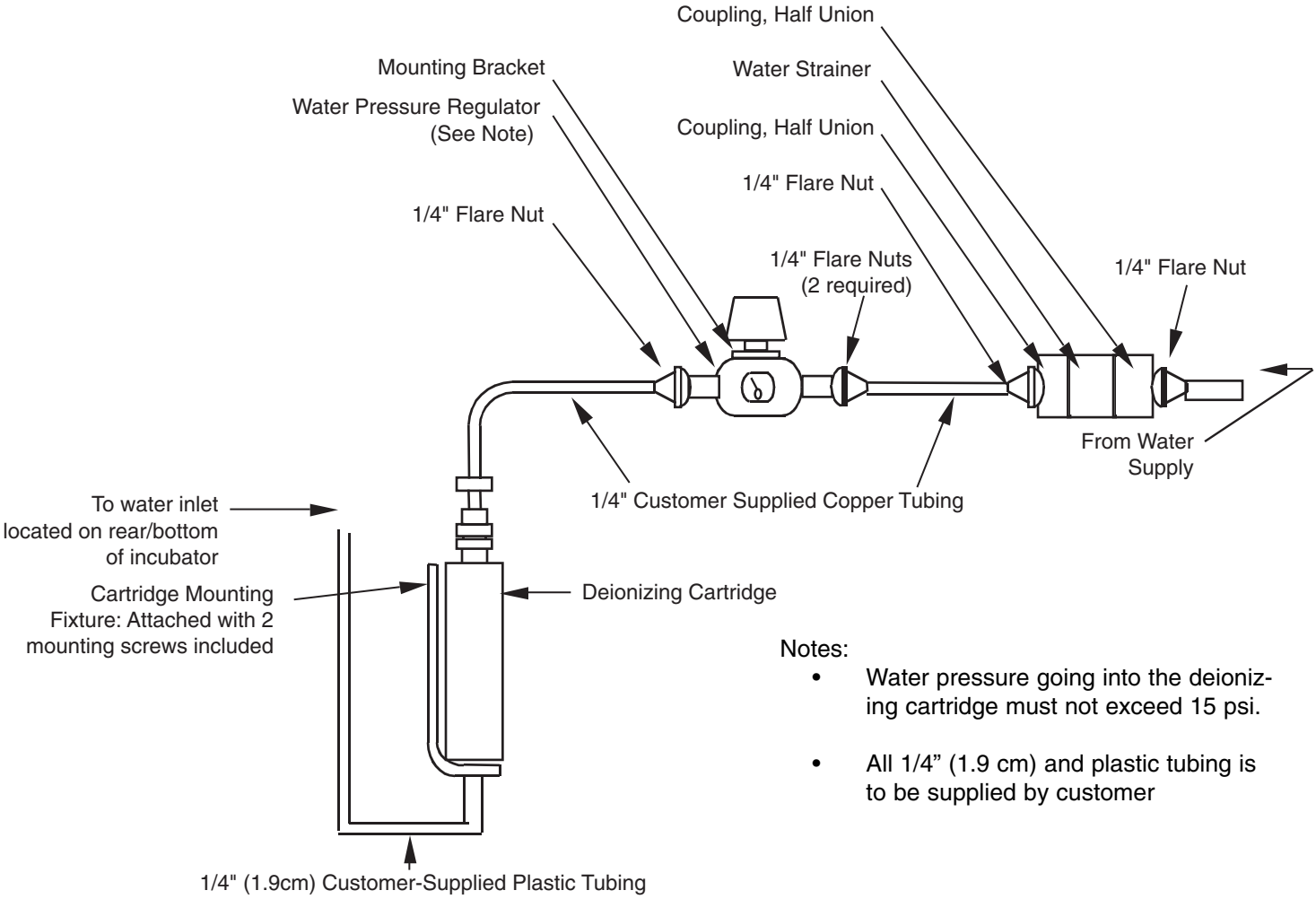
Use of Fungicide

While the addition of a fungicide to the water will assist in controlling contamination, it may also affect the results of experiments conducted with cells, viruses and other materials. These factors should be taken into account when deciding to use or not to use a fungicide.

Drain Fitting

A stopper is inserted into the opening on the floor of the chamber. Removal of this stopper opens the drain.

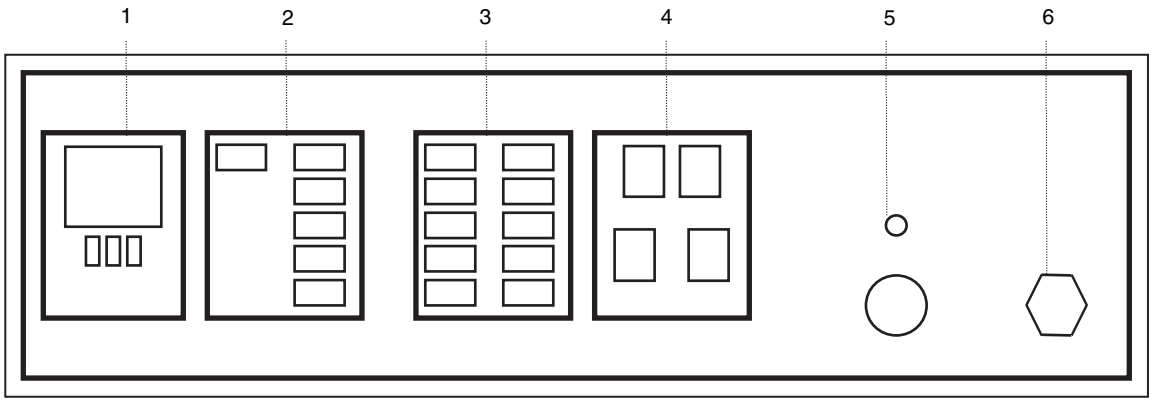
Water Deionizer Connections



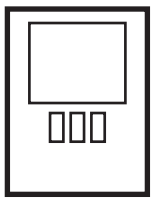
Notes:

- Water pressure going into the deionizing cartridge must not exceed 15 psi.
- All 1/4” (1.9 cm) and plastic tubing is to be supplied by customer

Features



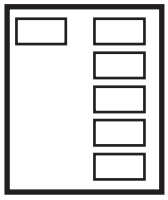
1. Display Module
2. Warnings Module
3. Programming Module
4. Function Keys Module
5. Hi-Limit Thermostat
6. Sample Port



Display Module

LED READOUT: This displays current chamber conditions and target set points for CO2 and temperature as well as door heat setting and calibration information.

- The indicating lights in the module serve to identify which of two parameters, temperature as degrees C or CO2 as a percentage value or RH as a percentage value, is being displayed.



Warnings Module

WARNING LIMITS: In the case of the first two listings that follow, an audible alarm (beep) and a flashing light are signaled if the factories set limits are exceeded. In addition, the alarm and light are used to warn of a change in the status of the next three listings but the audible sound is at a different rate.

The change in frequency of the audible alarm is used to identify for the user which of the following controlling condition has been affected.

- TEMP: High and low limit set points are factory set at ±1°C. Audible alarm (beep) frequency sound is at a MEDIUM rate, if the temperature deviates beyond the 1°C limits.

- CO2: High and low limit set points are factory set at ±1% above or below the user-established set point. Audible alarm (beep) frequency is at a MEDIUM rate, if CO2 should deviate from the 1% limit.

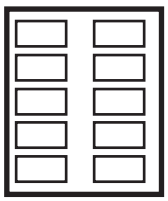
- POWER OUTAGE: A power outage status is signaled whenever power has been off. This will signal, along with routine turn-off and start up, when an accidental power outage occurs allowing the user to evaluate any possible effect on incubation work in progress. Audible alarm (beep) is at a SLOW frequency rate and will continue UNTIL SOMEONE ACKNOWLEDGES THE SIGNAL AND PRESSES ANY KEY.

- DOOR OPEN. Audible alarm (beep) is at a SLOW rate. This alarm sounds ONLY WHEN THE DOOR IS LEFT OPEN FOR MORE THAN 5 MINUTES.

In addition to the preceding warnings, the unit will also trigger alarms in case of RTD sensor failure, CO2 sensor failure or critical system upset. The audible alarm will sound at a HIGH FREQUENCY rate.

Note
Decreases in temperature and CO2 due to normal door openings are tolerated without initiating the alarms. If the temperature or CO2 does not, for any reason, recover to operating set point within 30 minutes after closing the door, the appropriate audible alarm will then be initiated.

Note
The audible alarm portion of the warning-limit signal can be silenced for a period of 60 minutes by pressing any of the four control keys. This permits the user to diagnose and rectify the causative factor without the audible alarm serving as a reminder. The "warning" light signal, however, is unaffected and remains on until the problem is solved. It is recommended that any condition resulting in the alarms being activated be taken care of as quickly s possible to prevent more serious problems from developing.



Programming Module

The next module to the right contains commands that are accessed by the SELECT key.

CURRENT SET POINT: When lit, this indicates the current set point—for the temperature, CO2 or door heat—is being displayed in the LED readout.

- Selection for the display is made by advancing the SELECT button to TEMP, CO2 or RH.

ADJUST SET POINT: In this mode, you can change the respective set points for CO2 , temperature and percent door heat. After the numerical value is selected on the LED display using the YES/Up and NO/Down keys, the step is enabled only if the ENTER key is pressed.

- Use the SELECT button to access the function to be changed.

CALIBRATE: Calibration against known standards of temperature and CO2 is possible when in this command mode. The YES/Up and NO/Down keys are used to alter the readout to correspond with the reading obtained from known standards of temperature or CO2 measurement. Both temperature and CO2 calibration use the zero-point shift method.

SCAN?/HOLD: In conjunction with the YES/Up and NO/Down keys, the LED display can be changed to scan alternately between CO2 and temperature readouts or to hold the display of the particular function for indefinite viewing.

- When you advance to the SCAN?/HOLD command segment, the adjoining green light will flash. You can accept the SCAN mode by pressing the YES key. This commands the unit to display the temperature and CO2 values on an alternating basis (approximate 3-second cycle).

- On the other hand, if you press the NO key, the unit shifts into the HOLD command for displaying temperature or CO2 values. Pressing NO

results in TEMP and CO2 alternating. When the desired parameter to be held is lit, then press YES.

The following parameters within the programming module provide two indications: one as a programming parameter and one as a controlling parameter.

TEMP

- When you are in the PROGRAM mode and you select TEMP, you are enabled to adjust the temperature within 4 parameters: RAISE, LOWER, SET, CALIBRATE.

- In the absence of the PROGRAM mode, the lighted TEMP LED indicates that heating proportioning is occurring in the incubator chamber.

CO2

- In the PROGRAM mode, you are enabled to adjust carbon dioxide tension within the four parameters listed above.

- In the absence of the PROGRAM mode, a lighted CO2 LED shows when carbon dioxide is being injected.

RH (Relative Humidity)

- When you are in the PROGRAM mode and you select RH, you are enabled to adjust the relative humidity within the four parameters listed above.

- In the absence of the PROGRAM mode, a lighted RH LED indicates that moisture is being added to the incubator chamber.

Function Keys Module

YES/UP: This key is used to increase numerical values and to respond to SCAN?/HOLD and DECONTAMINATION queries.

NO/DOWN: This key is used to decrease numerical values and to respond to SCAN?/HOLD and DECONTAMINATION queries.

SELECT: This key is used to advance through the functions that control the operation of the incubator.

ENTER: After a numerical value has been selected through use of the YES and NO buttons, this button must be pressed in order to enter the value into the program.

Note
Any value selected without pressing the ENTER key will be invalid.

Other Control Features

HI-LIMIT

This is a backup high-limit temperature thermostat which functions in the event that factory-set high and low limits for the temperature are rendered invalid as a result of overall system failure. This feature saves important incubation work from being affected by possible temperature overrun.

The backup high-limit thermostat should be set EACH TIME the set point temperature is changed.

SAMPLE: This access port is available for sampling the atmosphere in the chamber when executing calibration procedure such as might be done using a Fyrite or similar chemical-based CO2 analysis procedure.

Note
It is our recommendation that this unit run 24 hours empty before introducing media to be incubated. This will facilitate ease of servicing, if required, and nullify the need to decontaminate the chamber in the event of a problem occurring.

This unit cannot be accepted for servicing or credit by the factory unless accompanied by a certification of decontamination form—a form to copy is included in the back of this manual.

Operation

Warning
Do not use in the presence of flammable or combustible materials or explosive gases. Do not use in the presence of pressurized or sealed containers – fire or explosion may result, causing death or severe injury.

Warning
Do not heat any substance above a temperature that will cause it to emit toxic fumes; death or severe injury may result.

Warning
Use only an inert gas such as carbon dioxide in the incubator. Do not under any circumstance inject oxygen or other explosive gas or mixture into unit. Failure to observe these precautions can result in explosion and/or fire and serious injury or death and property damage.

Note
Under normal operating conditions, the HI-LIMIT led should never come on. If it does, readjust HI-LIMIT screwhead slightly clockwise.

HI-LIMIT setting must be changed with each change in operating temperature set point.

Use the select key and mode to adjust set point and CO2. Use YES/UP and NO/DOWN keys to select desired CO2 tension. Press ENTER.

Startup and Operation

1. Connect unit to power supply meeting the requirements as noted on the nameplate.

2. Turn on the incubator with power switch that is located on the right side just underneath the command console.

3. All of the lights in the command control console will light as unit conducts self-test to indicate that it is ready for operation. After an approximate 5-second interval, the lights will extinguish with the exception of the one adjoining the power outage legend. Press any key to extinguish this light.

NOTE: AFTER FIRST-TIME USE, ALL PREVIOUSLY ESTABLISHED SET POINTS ARE SAVED IN NON-VOLATILE MEMORY.

NOTE: CO2 IS FACTORY-CALIBRATED FOR OPERATION AT 37ºC AND 75% RH, ALL OTHER VALUES REQUIRE CO2 CALIBRATION.

4. Use the SELECT button of the programming module and advance to ADJUST SP and RH. Use YES and NO buttons to select the desired RH value. Press ENTER.

5. Use the SELECT button and advance to ADJUST SP and TEMP. Use YES and NO buttons to select the desired operating temperature. Press ENTER.

6. Using a small screwdriver, insert in HI LIMIT access hole and turn fully clockwise.

7. Use the SELECT key and advance to ADJUST SET POINT and CO2. Set CO2 set point to zero. Accuracy will not be achieved until the temperature and relative humidity parameters have stabilized.

8. Allow sufficient time for the unit to reach and stabilize at the selected set points plus an additional hour or two for unit to cycle at these levels.

9. After this time has elapsed, rotate the HI-LIMIT screwhead counter- clockwise while watching the

red status lamp. When the status lamp is lit, the thermostat set point for the operating set point temperature has been reached. Now rotate the thermostat screwhead clockwise 30º past the point where the lamp goes out. **This distance should be similar to the distance from the twelve o'clock to the one o'clock positions.**

Note
Do not adjust any potentiometer other than specified here! Failure to comply will drastically alter calibration warranty!

Temperature and CO2 Calibration Instructions for Incubators with Recorders

Tools needed to perform this calibration:

- Standard tuning tool for potentiometers (or jewelers tool)
- Fyrite CO2 analyzer

NOTES:

- This calibration procedure includes a four-hour waiting period for chamber equilibration.
- The cover to the unit must remain off to allow access to potentiometers during calibration.
- Locate and familiarize yourself with the CO2 ZERO (on the front panel) and CO2 SPAN (on the PCB) pots beforehand. Be aware of the live AC section on the board also... take all precautions.

IMPORTANT USER NOTE: There are ***TWO*** CO2 calibration procedures given in this text:

- One for routine CO2 calibration (i.e. week-to-week) calibration,
- One for full CO2 calibration (i.e. if a new sensor is installed, or if there is an unusually large discrepancy between readout vs. Fyrite measurements).

Note
Digital calibration from the front panel is not available on incubator models utilizing analog recorders.

Routine CO2 Calibration

The CO2 reading can be calibrated against a known standard such as the Fyrite method of analyzing CO2. Using a Fyrite or similar device, obtain the actual CO2 tension in the chamber via the front panel CO2 sample port. If there is a difference between the Fyrite reading and the CO2 reading displayed, use jeweler's type screwdriver to adjust the CO2 pot to make the two readings coincide. All CO2 data will track this change and CO2 control will correspond accordingly.

Full CO2 Calibration Procedure

1. Making sure that the inside components are back in place and secure, set the incubator temperature set point to users desired temp (usually 37.0 C). Set the CO2 set point to 0.0%. There must be NO CO2 inside the chamber at this time.

2. If the user is going to use RH, make sure that it is set to desired percentage now. As a rule, we ALWAYS recommend RH in the chamber for the best CO2 stability.

3. Use the “SCAN/HOLD” push-button switch from the Menu items to HOLD the CO2 reading. The LED readout should be locked onto CO2 now.

4. **** MOST IMPORTANT**** You MUST allow at least four hours from this point for the chamber to equilibrate both temperature and RH.

5. ZEROING: Now that at least 4 hours have passed, rotate pot CO2 ZERO POT (ON THE FRONT PANEL) until an LED reading of 0.1% CO2 is present. Let stand a few minutes, at which time verify that the reading is still 0.1%. If not, readjust pot “CO2 ZERO” and repeat check.

6. Adjust the CO2 set point to what the user will be using (usually 5-7% CO2). Allow the CO2 to reach set point and hold for at least 10 minutes before continuing.

7. SPANNING: Perform a Fyrite check of the chamber CO2 content. Careful attention to proper sampling is critical at this point. If any doubt exists about the actual CO2 concentration, re-sample to verify.

8. Locate pot "CO2 SPAN" on the PCB. Calculate a value corresponding to 1/2 the difference between the Fyrite value and the readout value. Rotate the SPAN pot until this calculated value appears on the incubator display.

Example 1: Incubator Readout = 7.0% CO2
Fyrite Indication = 5.0% CO2
Reading Difference = (7.0 - 5.0) = 2.0%
2 Difference (midway point) = 6.0%, therefore, rotate the SPAN pot until the incubator display indicates 6.0% CO2.

Example 2: Incubator Readout = 4.0% CO2
Fyrite Indication = 3.0% CO2
Reading Difference = (4.0 - 3.0) = 1.0%
2 Difference (midway point) = 3.5%, therefore, rotate the SPAN pot until the incubator display indicates 3.5% CO2.

9. Allow time for the incubator to once again recover to CO2 set point and equilibrate. Perform another Fyrite check of the chamber CO2 content. If at this time there is still a difference between the Fyrite reading and the CO2 display, go back to step 8 and again calibrate the SPAN pot for 1/2 the new difference. Re-verify for accuracy. (Typically, calibration should not require more than two or three "passes" through steps 8 and 9.)

10. At this time the LED readout and Fyrite readings should agree.

Temperature Calibration with Recorder

The incubator is calibrated at the factory. However, if required, the temperature readout may be calibrated from the front panel by accessing the temperature calibration pot. It is important to have access to a calibrated temperature-indicating device for this procedure. Insert the temperature indicator in the Incubator and allow the temperature to stabilize for approximately 4 hours. Using a jeweler's type screwdriver, adjust the temperature pot, **TEMP CAL**, on the front panel to match the reading obtained with the calibrated temperature-indicating instrument. All temperature data will track this change and temp control will correspond accordingly.

Temperature Calibration without Recorder

The incubator is calibrated at the factory. However, if required, the temperature readout may be calibrated from the front panel by accessing the programming module's CALIBRATE function and TEMP modes using the SELECT key. Use of a calibrated indicating device is critical to this procedure. Use YES/Up and NO/Down keys to correct the displayed temperature on the LED readout to match your chamber temperature reading and then be sure to ENTER the new value. All internal temperature parameters automatically track this change.

Upon entering the CALIBRATE mode, a value is displayed with 2 or 3 LED decimal points—example: 3.4.2.—adjoining the outside numbers. This numerical value is important for service technicians for calibration purposes, in the event that temperature or CO2 sensors are changed.

CO2 Calibration without Recorder

The CO2 reading can be calibrated against a known standard such as the Fyrite method of analyzing CO2. Using a Fyrite or similar device, obtain the actual CO2 tension in the chamber via the front panel CO2 sample port. (Carefully follow the instructions in the Fyrite manual.) If there is a difference between the Fyrite reading and the CO2 reading displayed, use the programming module's SELECT key to access CALIBRATE and CO2 mode. Use the YES/Up and NO/Down keys to correct the displayed CO2 value to match that value obtained with the Fyrite or device of comparable accuracy and reliability. Be sure to ENTER the change. All internal CO2 parameters automatically track this change.

Please read the following carefully in order to ensure accuracy in the CO2 calibration procedure.

Thermal Conductivity Cell

The thermal conductivity cell (TC) CO2 sensor is sensitive not only to CO2 tension but also to changes in relative humidity (RH) and to the temperature (TEMP), as well. This sensitivity to moisture and temperature must be taken into account when CO2 calibration is to be made.

Normally, the 393 incubator is to be operated at one specific RH and TEMP setting, for example, 37ºC and 75% RH (which are the settings used for factory calibration of the unit). These, the OPERATING SET POINTS, must be reached and maintained (equalize) PRIOR to zeroing the CO2 circuitry. As long as there are no significant changes to either the TEMP or the RH setpoints, the CO2 will be accurate.

However, if you change, for example, the RH setpoint from 75% to 95%, the CO2 zero must be calibrated again, in order for the unit to display and control the correct CO2 concentration. This is done using the programming model's CO2 CALIBRATE mode in either of two ways:

- Eliminate all CO2 from the chamber (CO2 set point = 0.0) and wait for RH and TEMP to equalize. When equalized, calibrate the CO2 to read

0.1% using the UP/DOWN keys on the panel. Then simply enter the desired CO2 operating level.

- Make the desired RH and/or TEMP changes. Leave the CO2 set point as is. When the RH and TEMP set points are reached and equalized, take a Fyrite reading of the chamber CO2 and then access the CO2 calibration mode and adjust the reading until it corresponds with the reading as obtained with the Fyrite method.

The last method is perfectly acceptable but it must be understood that while you are waiting for the RH and/or TEMP set points to equalize, the CO2 readings will be incorrect—the degree being dependent on the change of the new RH/TEMP settings. Therefore, if you have cultures inside, it is best to use the first method listed. The 393 incubator has very rapid rise times for RH and TEMP and the first method will usually take under one hour to equalize.

CO2 Accuracy

As long as the RH and TEMP values are kept constant, TC-type CO2 sensing is sensitive only to changes in CO2. Two points, however, must be addressed: Fyrite techniques and door openings.

Fyrite Techniques

Measuring chamber CO2 by utilizing a chemical analyzer is by far the preferred method of checking calibration. What follows here will not discuss all of the details involved in performing routine chemical analysis of the chamber CO2 concentration but will emphasize the importance of proper methodical sampling techniques in order to achieve optimum results. Your Fyrite manual goes into detail as to the proper method to gain satisfactory results and, as such, should be studied carefully, especially if you have had little or no experience with the method. Practice makes perfect, and taking proper Fyrite readings will soon become second nature. See upcoming "Hints on Using the Fyrite."

Door Openings

Whenever the door is opened to the chamber, there is a rapid loss of CO2, RH and temperature, as might be expected. This poses no problem; the chamber will recover all these parameters within minutes after the door is closed. However, you should understand that while the door is open and until the TEMP and RH have recovered back to set point values, CO2 readings, most likely, will be incorrect. This is due, once again, to changes in both RH and TEMP following the door opening and as such must also be considered as normal.

It is typical for a chamber calibrated at 37ºC and 75% RH to display as much as 5% CO2 while the door is open when there is actually only an ambient amount inside. The deviation from normal is always in a positive direction and as such will never allow more CO2 than is desired (CO2 set point) during the time that CO2 calibration recovers. Normally, this CO2 mis-calibration only lasts a few minutes following a door opening and should always be expected on TC-type CO2 controls running at any setting other than ambient.

Hints on Using the Fyrite

The following information is intended to supplement that found in the Fyrite manual and is based on experience working with users of our incubators.

One of the most important aspects of using the Fyrite procedure and one that is frequently overlooked is the condition of the fluid. The Fyrite accepts a sample of the Incubator's environment into its own chamber where it is absorbed by the Fyrite fluid to determine the CO2 percentage or tension. Keeping outside air from the sample drawn from the Incubator is of special importance. Any outside air contaminating the sample is detrimental to an accurate reading, and more importantly, to the growth of your cells. Inspection of the fluid should be performed only with the user wearing protective gloves, as the Fyrite fluid is slightly corrosive. The inspection should review the following:

- **THE DATE OF THE LAST FLUID CHANGE:** Old fluid will not absorb as much CO2 and will produce a false reading. This may lead the user

Note
A little water goes a long way. Use only a couple drops of distilled water at once.

Caution
Do not use Fyrite fluid to adjust the level of fluid use distilled water only. The only time to use fresh Fyrite fluid is when you change it due to the age of the fluid.

to recalibrate the Incubator to higher CO2 tensions that can prove lethal to cell cultures. Fyrite fluid should be changed after approximately 350 uses. This approximates a change of fluid once a year if the Fyrite procedure is carried out on a daily basis. Keep track of the number of uses and if the Fyrite is used with more than one Incubator. Experience shows that the color of the fluid is not as important as the age of fluid.

- **CHECK THE CONTAINMENT VESSEL AND HOSES AT LEAST ONCE A MONTH:** Make sure that there are no cracks in the vessel or leakage of fluid to the outside of the container. This can indicate a leaky seal or internal crack. Hoses should be stretched slightly and inspected for cracks or holes. This is critical as cracks and/or holes in the hoses can draw in outside ambient air and produce a false reading.

- **CHECK THE FLUID DAILY AND ADJUST THE SLIDE GAUGE TO READ ZERO:** If you have adjusted the slide gauge all the way down and the fluid level is still too low, place a couple of drops of distilled water into the plunger on the top of the Fyrite. Depress the plunger and the water will transfer into the Fyrite causing the fluid level to rise. Repeat this procedure until the fluid level reads correctly.

- Inspect the Fyrite filter in the clear plastic casing between the hoses for any contamination or growth. Change it if necessary. CAUTION: MAKE SURE THE FILTER IS MOIST BEFORE YOU TAKE YOUR READING. A MOIST FILTER IS A MUST FOR AN ACCURATE READING.

  To moisten the filter:
  1) Remove the end of the short hose without the squeeze bulb that connects to the incubator.

  2) Add several drops of distilled water to the filter, replace the hose and squeeze the bulb.

  3) Release the bulb and the water will be drawn into the filter.

4) Squeeze the bulb and quickly release it to remove any excess water. You will see this water (if any) come out of the end of hose that is closest to the squeeze bulb. This is the cupped end that is depressed onto the Fyrite.

Caution
The incubator must be stable.

Taking a Fyrite Reading

It is recommended that Fyrite CO2 and independent temperature tests be performed at intervals to be determined individually or as dictated by established protocol. Some laboratories conducting critical work may want to record CO2 and temperature readings on a daily basis.

1. Clear the Fyrite of any residue CO2. Simply depress the plunger on the head or the top of the Fyrite taking care not to cover the hole. This introduces fresh ambient air into the Fyrite chamber.

2. Release the plunger and turn the Fyrite upside down, holding it at a 45-degree angle until most of the bubbles surface and the fluid has filled the head. Even the smallest bubbles may contain CO2, so that it is important to let most of the smaller bubbles surface.

3. Turn it right side up and hold it at 45 degrees. Allow the fluid to fill the Fyrite and depress the plunger again. This clears the Fyrite of any CO2 that might cause a false reading.

4. Attach the filter side of the hose to the incubator's CO2 sample port. Remove the brass tube, if present, from the Fyrite hose, as it is not needed and attach the hose to the CO2 sample port. (The brass tube was once used with older incubators that utilized a hole in the Incubator wall or door to measure CO2 but this method proved to cause contamination problems.)

5. LOOK AT YOUR FYRITE GAUGE AND ADJUST THE ZERO IF NECESSARY. Take the squeeze bulb end of the hose and with the hole of the cupped end facing down, place it onto the

plunger of the Fyrite and hold it firmly in position. IMPORTANT: ONCE YOU HAVE DEPRESSED THE PLUNGER OF THE FYRITE, IT IS CRITICAL THAT IT NOT BE RELEASED DURING THE FOLLOWING PROCEDURE.

6. Depress the plunger and hold it down. It is very important not to allow the plunger to spring up— if this occurs, you will be repeating an already existing reading. It will not matter how many times you pump the squeeze bulb, as long as you hold the plunger down you will introduce only one sample to the Fyrite. But, by releasing the plunger and immediately pushing it back down, you will then be adding an additional sample to the Fyrite chamber causing the reading to double or triple. In the event that it is difficult to hold the plunger down while pumping the squeeze bulb, find a more suitable or comfortable position.

7. Without releasing the plunger, pump the squeeze bulb at least 20 times— this assures complete and thorough transfer of the sample to the Fyrite chamber.

8. Once the bulb has been pumped the required number of times, HOLD THE SQUEEZE BULB IN THE "SQUEEZED" POSITION and release the pressure on the cup that will also release the plunger. This traps the sample from the Incubator in the Fyrite chamber and allows the fluid to absorb the CO2.

9. With the plunger now released, turn the Fyrite upside down again and hold at a 45-degree angle to allow the smaller bubbles to surface while the fluid fills the chamber head.

10. Reverse and turn Fyrite right side up and hold at a 45-degree angle to allow the same thing to happen. Repeat this procedure.

11. Hold upside down at 45-degree angle and right-side up at 45-degree angle. Finish by shaking the Fyrite slightly while holding at 45-degree

angle to allow residue droplets of fluid to drain into the measuring tube.

12. Read the gauge: It should match or be close to your CO2 set point. It is possible that you may be off as much as ±3%. If you read more than 8%, it is possible that you may have introduced two samples or the Incubator is way out of calibration. If a wide variation between the reading and CO2 set point exists, it is recommended that the sampling and measurement procedure be repeated.

13. Once the possibility of any error in Fyrite reading has been eliminated, calibrate your incubator to conform to the reading obtained.

Note
IT IS STRONGLY SUGGESTED THAT A FYRITE READING AND A TEMPERATURE READING BE PERFORMED AND LOGGED ON A DAILY BASIS—it takes only about 5 minutes and will improve incubation protocols and can forewarn of possible incubator problems before they become serious.

Maintenance

Warning
Disconnect from the power supply prior to maintenance and servicing.

Warning
Refer servicing to qualified personnel.

Cleaning

Every 6 months, inspect the chamber. If water is added for humidity, remove any scale accumulation. Clean the stainless steel interior with any good scale remover or dilute acetic acid and a synthetic scouring pad. DO NOT USE chlorine-based cleansers or bleach, scouring pads with metallic content, or harsh abrasives to clean any part of the incubator.

Care and Cleaning of Stainless Steel

WARNING: Electrolysis can damage stainless steel. This occurs when an object is allowed to rest directly on the surface of stainless steel, trapping moisture that becomes oxygen-starved, but is surrounded by water containing oxygen.

The Alloy Called Stainless

Stainless steel is an alloy of steel with chromium and nickel that increase the metal's resistance to rust and corrosion. Yet, if not properly cared for, stainless steel can rust and corrode.

Exposure to air provides the passivation, or oxide layer coating, for clean stainless by producing a thin, durable chromium-oxide film that forms rapidly on the alloy surface to give stainless its characteristic "stainless" quality. Also exposure of the surface to other oxidizing environments can produce a passivating film or coating.

However, if free oxygen is not available due to scale or contamination buildup the metal surface may become vulnerable to rusting and corrosion as well as pitting. But by maintaining neutral pH and conducting frequent cleanings with detergent and water, years of trouble-free service from stainless steel products can be obtained.

Stainless Guidelines

Distilled water is recommended. Please note, if this water is very pure it may be corrosive to stainless. When filling a bath or incubator, ALWAYS add 2 to 40 ppm (20 to 40 mg/liter) disodium phosphate or sodium bicarbonate, adjusting dosage to

provide a pH value of 7 to 9. If not available, use clean, aerated soft tap water provided the total solids concentration is < 500 PPM. We do NOT recommend using 18 meg-ohm deionized water. If this is the only source of treated water available, mix with regular tap water at a 50/50 ratio.

The pH Factor

Check pH regularly. If pH is <6.0, add disodium phosphate to increase pH to a 7 to 9 value. Sodium carbonate or sodium bicarbonate may be used but they tend to form scale that must be rinsed out regularly. If pH is >10.0, add sodium bisulfate to decrease pH to a 7 to 9 value. Avoid adding harsh alkalines or acids since these may cause localized corrosion and result in unstable pH.

Special Considerations

WARNING: If it is necessary to use the following chemicals, limit exposure time to a maximum of 3 hours. Always clean surfaces immediately after use.

Aluminum chloride
Barium chloride
Calcium chloride
Chlorinated Lime
Citric acid (boiling)
Dakin's solution
E.D.T.A.
Ferrous chloride
Lysol
Mercury salts
Phenol
Potassium permanganate
Potassium thiocyanate
Sodium hypochlorite
Stannous chloride
Tartaric acid

BE ADVISED: Never use the following on stainless steel:

- Aqua regia
- Ferric chloride
- Iodine
- Sodium acid
- Sodium azide

Chemical spills, especially those agents listed here, should be removed as soon as possible and the stainless steel surface cleaned with mild soapy water followed by a clean water rinse.

Cleansing Agents

Anti-fungal and anti-bacterial additives are permissible to use as long as the pH of the aqueous solution is kept within the range of 7 to 9. These are available through laboratory distributors. Be sure to CONFIRM that they are not harmful to stainless steel.

Cleaning Methods

Do not use any metallic pads. Instead, for stubborn stains, use a plastic light-duty cleansing pad and rub gently in the direction of the metal grain.

Note
The use and disposal of these chemicals may be regulated by your local city codes; consult those regulations before disposing of these materials.

If stains continue to persist, use one of the following chemicals and methods.

CAUTION: Extreme care must be taken when handling these materials. Always work in an area with adequate ventilation. Use the precautions as outlined in the Material Safety Data Sheet (MSDS) and the manufacturer's instructions for the product being utilized. Also, follow the personal protection index found in the hazardous materials information system (HMIS) section of the MSDS.

- Any of a variety of "scale removers" available at local supermarkets or hardware stores used for the cleaning of coffee marks, humidifiers or vaporizers.
- A 15% to 35% phosphoric acid solution available from laboratory supply distributors for scale and rust removal. Allow solution to soak the surface affected until rust and scale is loosened. Immediately follow with a clean water rinse.
- Citric acid based cleaners.
- Bathroom tub and tile cleaners.
- A mixture of 20% nitric acid and 1.5% hydrofluoric acid (or hydrochloric acid). Swab solution on surface allowing it to remain until rust is loosened. Immediately follow with a clean water rise. This method should ONLY be used if SEVERE rust and scale stains are present.

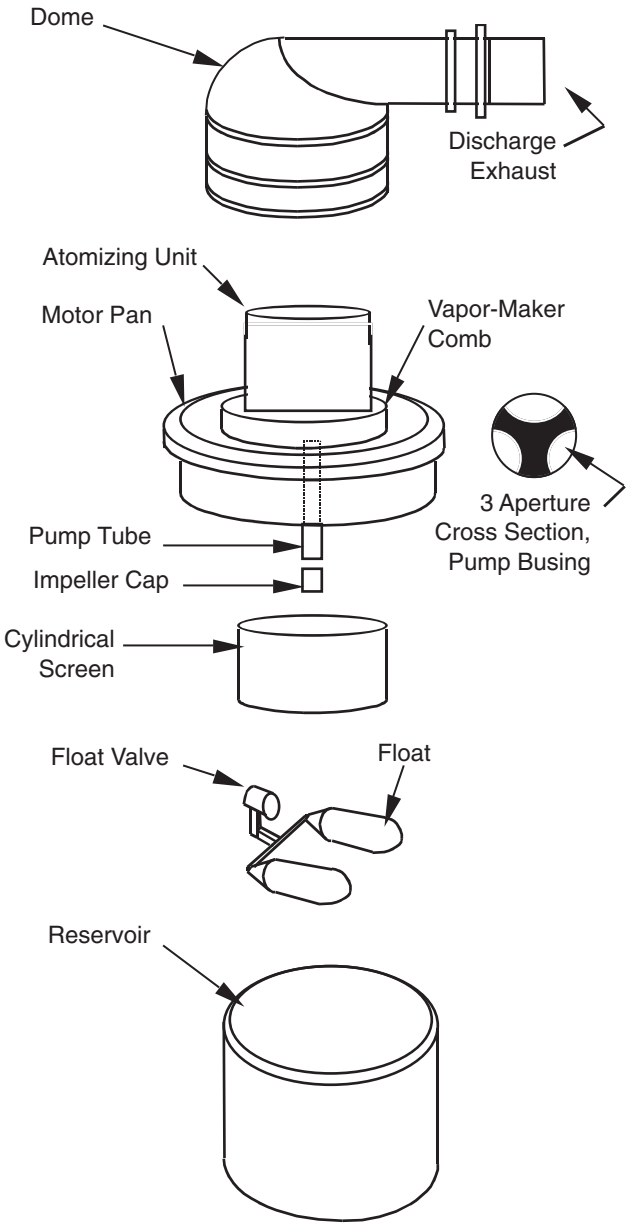
- Oxalic acid 2% to 5% in warm water. Swab solution on surface allowing it to remain until rust is loosened. Immediately follow with a clean water rinse. This method should ONLY be used if SEVERE rust and scale stains are present.

Regardless of the approach utilized, ALWAYS follow the manufacturer's directions and allow the chemicals to do the cleaning with MINIMAL scrubbing. Always follow cleanings with a clean water rinse. Air dry.

Note
This information is intended as guidelines only and we make no claim as to the suitability to any particular situation. Consult your staff chemist to determine what would be best for your stainless steel product and laboratory.

Materials Effective in Disinfecting

- Glutaraldehyde
- Alcohol



Periodic Cleaning and Inspecting of Humidifier

1. Disconnect both electrical plugs from the outlet. Turn off water supply.

2. Remove dome from unit after first removing the dome strap. The dome rests on the chromed motor pan. It lifts out and away from the duct and the unit. Tube seal is on the dome discharge exhaust and will be carried with the dome.

3. Lift out the atomizing unit—this rests freely on the reservoir and lifts out easily.

4. Clean the atomizing unit. DO NOT SUBMERSE IN WATER. First, remove the cylindrical screen—twist slightly out of the LOCK position and remove. Next, remove the impeller cap from the pump tube by tapping lightly against the bottom edge of the cap. DO NOT TAP FACE OF CAP. Gently free the 3 apertures inside the pump tube of any solids that may have accumulated. Replace impeller cap on the pump tube. Tap lightly into place around edge. DO NOT TAP FACE OF IMPELLER CAP. Spin the pump tube by hand to ensure that it rotates freely. Replace screen by twisting into LOCK position. Brush-clean vapor maker comb. Clean out motor pan. Discard waste.

5. Empty and clean reservoir of all liquids and waste—care should be taken so as not to disturb floats or float valves. Check float valve operation before reassembly.

6. Reassemble unit. Replace the atomizing unit on the reservoir. Place the dome on the chromed motor pan with the discharge exhaust and tube seal inserted in place.

7. Turn on water supply valve and plug in both electrical cords before running dehumidification again.

Replacement Parts

DESCRIPTION	PART NUMBER
Axial Fan:	160-055-01
Circuit Breaker, 15 Amp:	330-124-00
Temp & Humidity Sensor Assembly:	017-924-00
Adjustable Foot Assy:	012-267-00
Gasket:	530-069-00
Heater, 120 V, 200 W:	340-290-00
Heater, Main Chamber, 120 V, 800 W:	340-291-00
Line Cord:	470-105-00
Motor:	370-235-00
Relay, 24 VDC:	400-160-00
Relay, 120 VAC:	400-161-00
Humidifier Assy:	012-331-00
RH Sensor:	924-032-00
RTD Temperature Sensor, Immersible:	410-632-00
Shelf:	582-982-01
Solenoid Valve, 2-Way:	950-135-00
Solid-State Relay:	400-233-00
Status Lamp, Red:	360-272-00
Switch, Door:	440-080-00
Switch, Power:	440-359-00
Switching Power Supply:	460-265-00
Thermostat:	920-301-00
Pilaster Clips:	170-029-00
Varistor:	410-629-00
Gas Interface Assy:	018-514-00
Wiring Diagram 393, 393-1:	228-389-00
Wiring Diagram 393-2, 393-3:	228-465-00
DI Cartridge Assy:	019-168-00

Ordering Procedures

Please refer to the Specification Plate for the complete model number, serial number, and series number when requesting service, replacement parts or in any correspondence concerning this unit.

All parts listed herein may be ordered from the **Thermo Scientific** dealer from whom you purchased this unit or can be obtained promptly from the factory. When service or replacement parts are needed we ask that you check first with your dealer. If the dealer cannot handle your request, then contact our Customer Service Department at 563-556-2241 or 800-553-0039.

Prior to returning any materials, please contact our Customer Service Department for a “Return Materials Authorization” number (RMA). Material returned without an RMA number will be refused.

Decontamination Statement

We cannot accept any product or component sent to the factory for repair or credit that is contaminated with or has been exposed to potentially infectious agents or radioactive materials.

No product or component will be accepted without a "Return Goods Authorization" (RGA) number.

Certification of Decontamination

We cannot accept for service or credit a product that has been exposed to or contaminated with chemically or biologically toxic or infectious substances or subjected to radioactivity without first being certified as free from said contamination.

Please have your Medical and/or Safety Officer sign this form certifying that proper decontamination procedures have been followed to render the product safe and free from hazards.

Any product forwarded to us that is not accompanied by this form and a proper Return Goods Authorization Number will be returned to the sender. To obtain Return Goods Authorization Number, contact: Customer Service Department at 1-800-553-0039.

We hereby certify that the Thermo Scientific product:

Model No._____ Serial No._____

that is being forwarded has been properly decontaminated and is free from all toxic hazards, infectious agents, radioactivity and/or other hazards.

Company/Institution Name: _____

Street Address: _____

City: _____ State: _____ Zip: _____

Name (please print): _____ Title: _____

Signature: _____

Phone: _____

DECONTAMINATION PROCEDURE (Be Specific): _____

_____

_____

_____

_____

_____

_____

Nature of Hazard That Required Decontamination: _____

_____

_____

_____

_____

Two Year Limited Warranty

This Thermo Scientific product is warranted to be free of defects in materials and workmanship for two (2) years from the first to occur of (i) the date the product is sold by the manufacturer or (ii) the date the product is purchased by the original retail customer (the “Commencement Date”). Except as expressly stated above, the MANUFACTURER MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED, WITH RESPECT TO THE PRODUCTS AND EXPRESSLY DISCLAIMS ANY AND ALL WARRANTIES, INCLUDING BUT NOT LIMITED TO, WARRANTIES OF DESIGN, MERCHANT ABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

An authorized representative of the manufacturer must perform all warranty inspections. In the event of a defect covered by the warranty, we shall, as our sole obligation and exclusive remedy, provide free replacement parts to remedy the defective product. In addition, for products sold within the continental United States or Canada, the manufacturer shall provide free labor to repair the products with the replacement parts, but only for a period of ninety (90) days from the Commencement Date.

The warranty provided hereunder shall be null and void and without further force or effect if there is any (i) repair made to the product by a party other than the manufacturer or its duly authorized service representative, (ii) misuse (including use inconsistent with written operating instructions for the product), mishandling, contamination, overheating, modification or alteration of the product by any customer or third party or (iii) use of replacement parts that are obtained from a party who is not an authorized dealer of Thermo Scientific products.

Heating elements, because of their susceptibility to overheating and contamination, must be returned to the factory and if, upon inspection, it is concluded that failure is due to factors other than excessive high temperature or contamination, the manufacturer will provide warranty replacement. As a condition to the return of any product, or any constituent part thereof, to the factory, it shall be sent prepaid and a prior written authorization from the manufacturer assigning a Return Materials Number to the product or part shall be obtained.

IN NO EVENT SHALL THE MANUFACTURER BE LIABLE TO ANY PARTY FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, OR FOR ANY DAMAGES RESULTING FROM LOSS OF USE OR PROFITS, ANTICIPATED OR OTHERWISE, ARISING OUT OF OR IN CONNECTION WITH THE SALE, USE OR PERFORMANCE OF ANY PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, TORT (INCLUDING NEGLIGENCE), ANY THEORY OF STRICT LIABILITY OR REGULATORY ACTION.

For the name of the authorized Thermo Scientific product dealer nearest you or any additional information, contact us:

2555 Kerper Blvd., Dubuque, Iowa, 52004-0797
Phone: 563-556-2241 or 1-800-553-0039
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E-mail: mkt@thermofisher.com
Web: www.thermo.com